The Modeling and Simulation on SRM Drive System Using Variable-proportional-desaturation PI Regulator

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VECOS, 2020

Outline

Introduction

- The application status of SRM speed regulation system.
  - Unique structure.

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Figure: The 6/4 pole structure diagram of switched reluctance motor.

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Figure: The application in vehicles.

Figure: The application in textile industry.

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  - nonlinear.
  - wind-up phenomenon*.
- The methods to improve the performance of SRM speed regulating system.

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- Direct Torque Control (DTC) control structure features.

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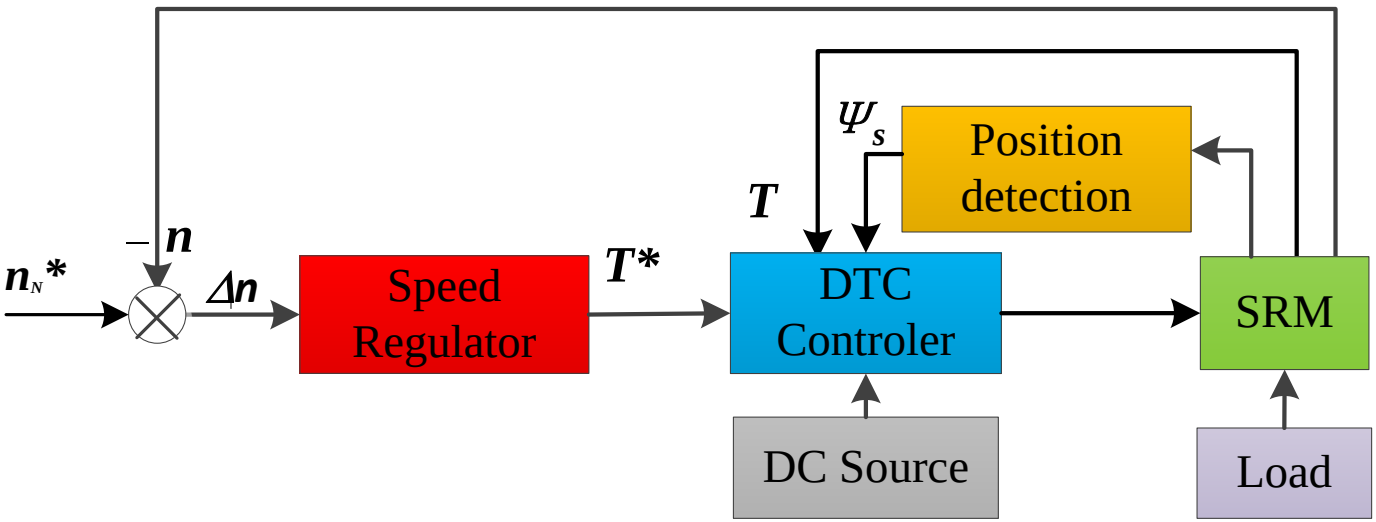

Figure: The SRM speed regulation system overall structure.

The optimized design of speed regulator for SRM drive system

- The design of DPI regulator.
- The design of VPDPI regulator.
- The VPDPI regulator parameter adjusting.

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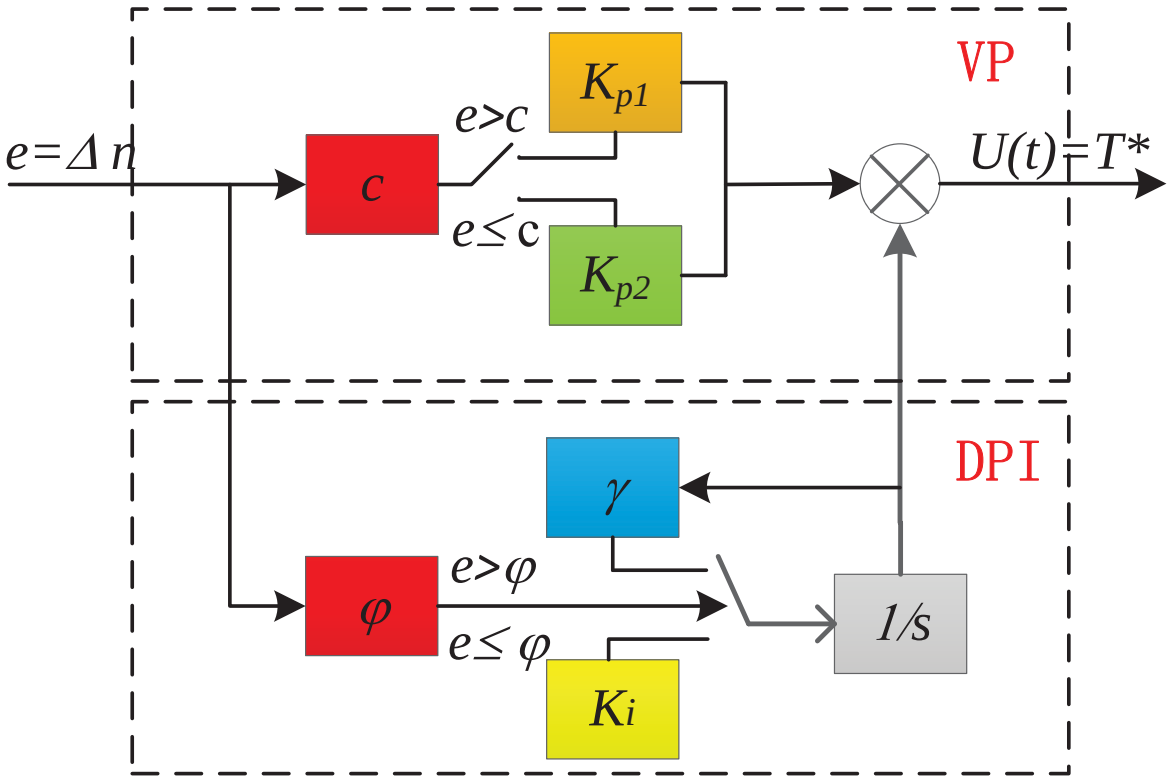

Figure: The structure diagram of VPDPI regulator control algorithm .

The main algorithm of VPDPI

Algorithm 1 The computation algorithm of $VPDPI$ for SRM drive system

Input: The given speed of SRM drive system n_N^*
Output: The referenced torque T_e^*

begin;
Setting n_N^*, c, φ
Identify and Sampling n at t time.
Calculating the error value of speed $e = n_N^* - n$
if $e \leq c$ **then**
    $\rho := 1$
    $K_p = K_{p2}$
else
    $\rho := 0$
    $K_p = K_{p1}$
end if
if $e \leq \varphi$ **then**
    $\gamma := 1$
else
    $\gamma := -2$
end if
Calculate $u(t) = [\rho(K_{p2} - K_{p1}) + K_{p1}]e + \gamma K_i \int edt$. Actually, $u(t)$ is the referenced torque T_e^* at t moment.
Output the referenced torque T_e^*.
end.

The VPDPI regulator parameter adjusting

The key steps in the parameter equivalence process of the regulator are as follows:

- How to equivalent inductance model.
- How to establish the relationship between the equivalent transfer function of the speed regulating system and the transfer function of the proposed regulator.

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The performance analysis of the drive system under rated speed with no-load operation

Assuming that the SRM drive system runs at rated speed with no-load.

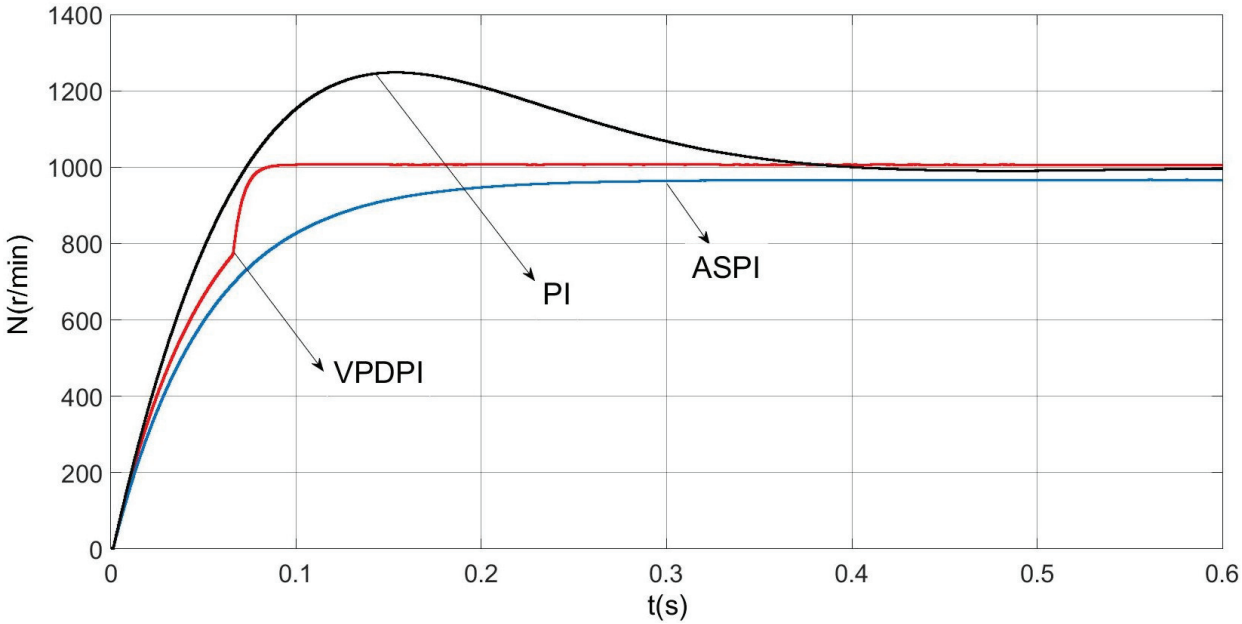

Figure: The waveform of the speed control effect of three PI regulators under constant speed and no load.

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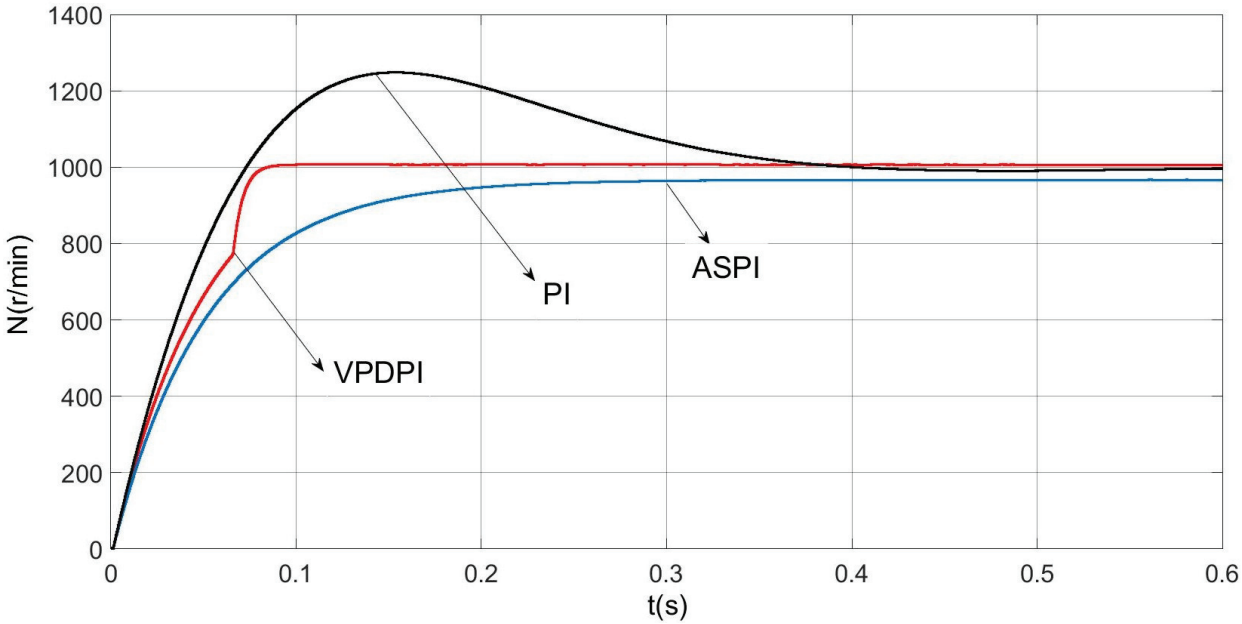

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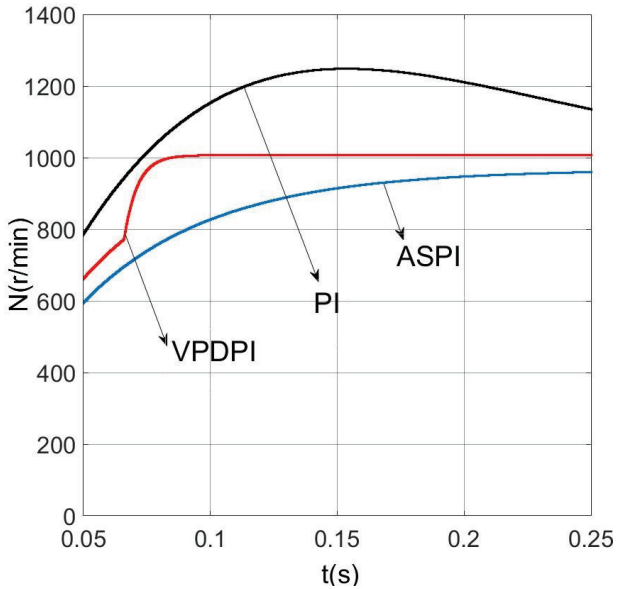

Figure: The amplification waveform diagram of speed control effect of three PI regulators under rated speed with no load.

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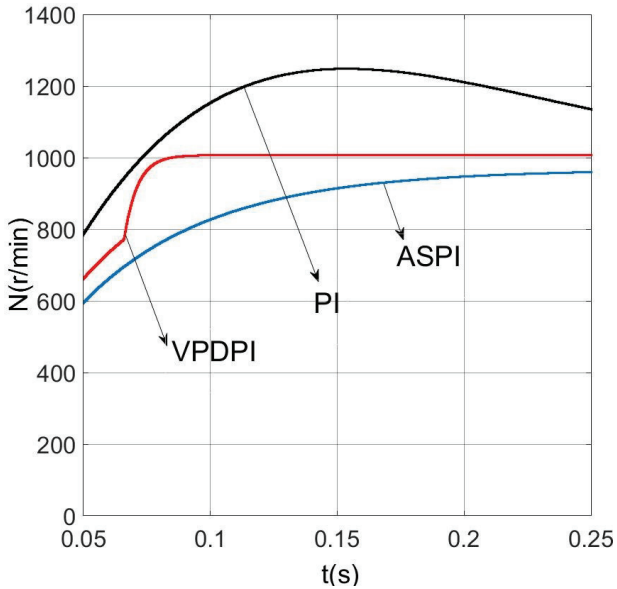
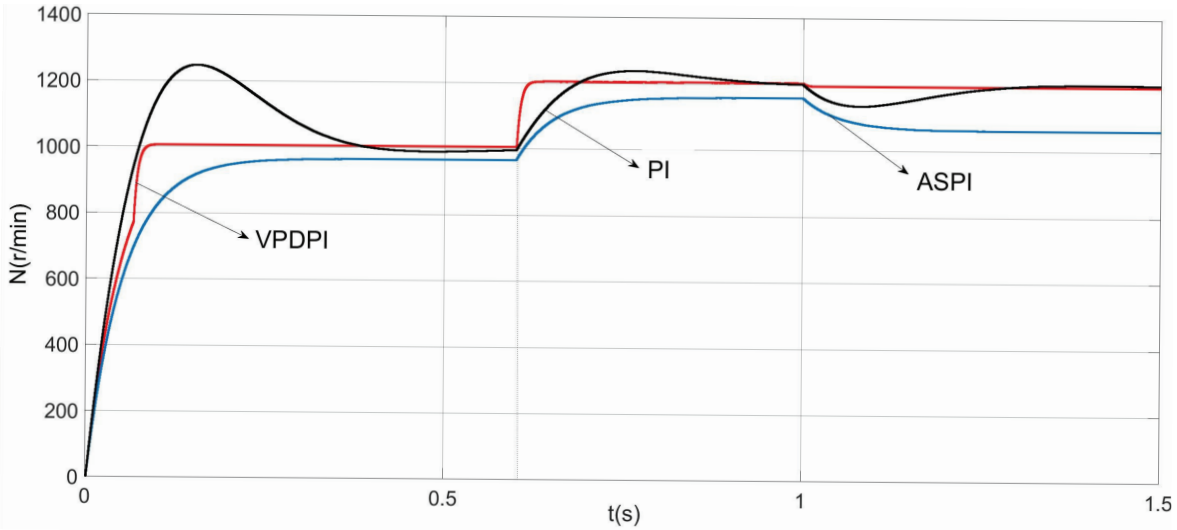


Figure: The amplification waveform diagram of speed control effect of three PI regulators under rated speed with no load.

The performance analysis of the drive system under variable speed and load operation

Assuming that the speed sudden changes from 1000 r/min to 1200 r/min at $t = 0.6s$. And the load changes from 0 N·m to 10 N·m at $t = 1$s.



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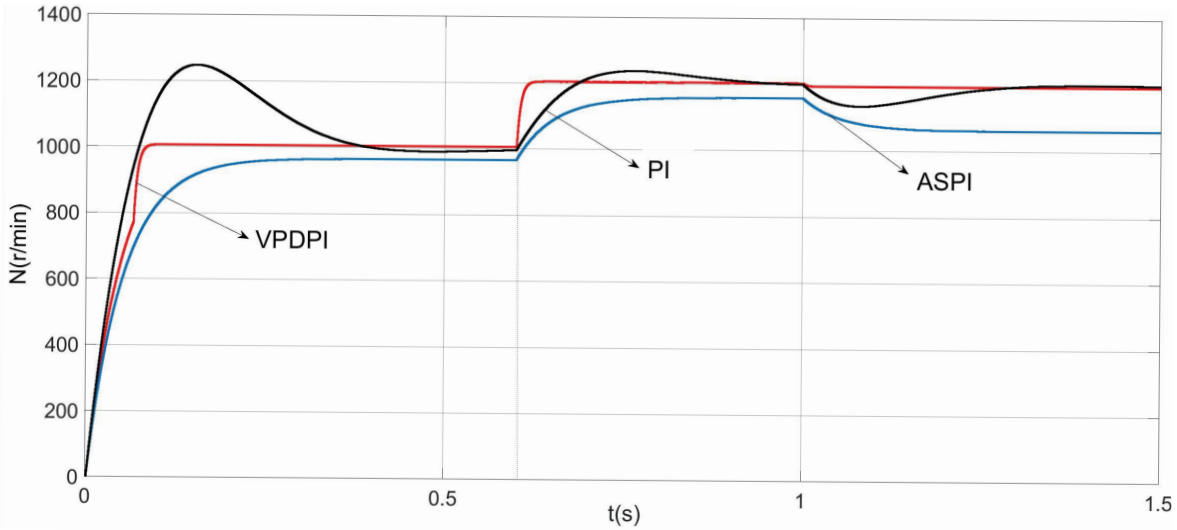

Figure: The waveform of speed control effect of three PI regulators under variable speed and load

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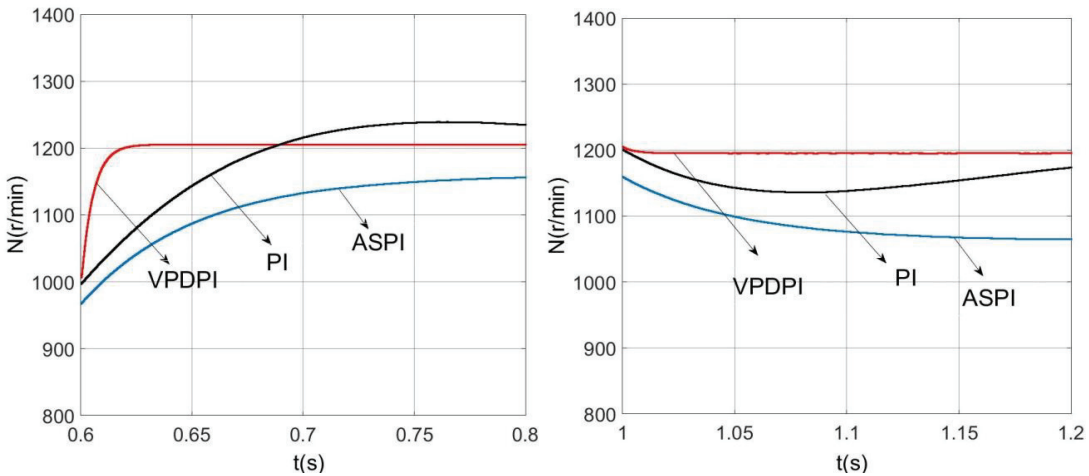
The zooming-in waveform of the steady-state value under variable speed(from 0.6s to 0.8s) and variable load (1s to 1.2s) are also given in Figure (a) and (b), respectively.



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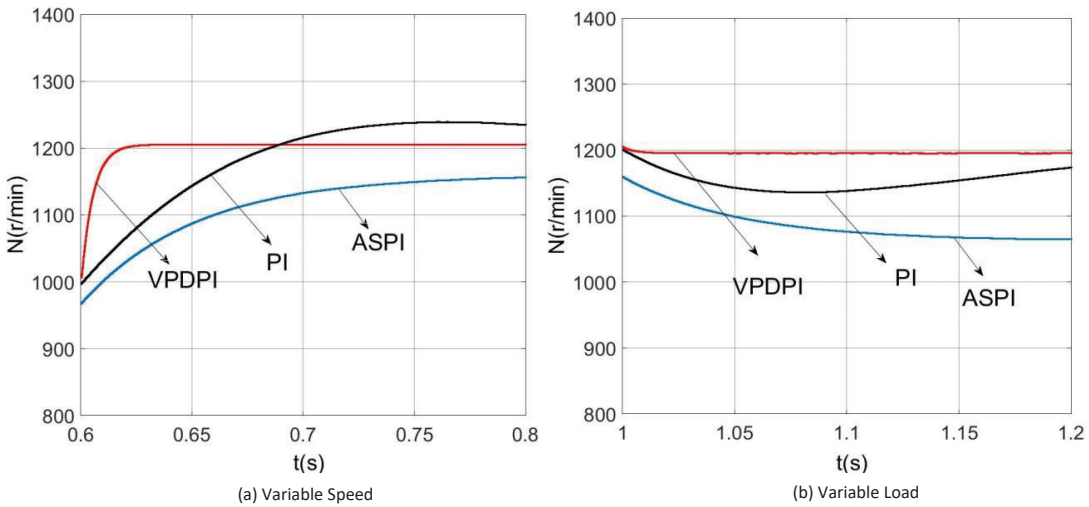

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3. The simulation verification of dynamic performance, steady-state performance and disturbance rejection performance.

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Author's brief introduction

ZHIHAN WEI was born in Liaoning, China, in 1998. He received his bachelor's degree from Shihezi University in 2020, and was excluded from the postgraduate program of Mechanical and Electrical College of Xinjiang Shihezi University in the same year, mainly engaged in research in the field of motor control and automation. His email address is weizihan615@163.com.

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Author's brief introduction

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Thank you for Listening and Welcome to ask Questions.

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